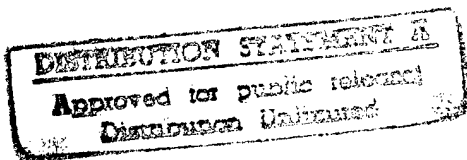


FINAL

EXECUTIVE SUMMARY

ENERGY SAVINGS OPPORTUNITY SURVEY  
U.S. ARMY FIELD STATION KUNIA  
OAHU, HAWAII



PREPARED FOR:

Department of the Army  
Pacific Ocean Division  
Corps of Engineers

UNCLASSIFIED

PREPARED BY:

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JUNE 1989

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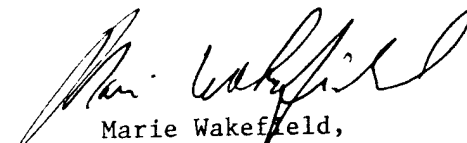


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## LIST OF REFERENCES

1. Army Facilities Energy Plan, 9 December 1984.
2. Engineer Technical Letters (ETL's):
  - a. 1110-3-254 Use of Electric Power for Comfort Space Heating
  - b. 1110-3-282 Energy Conservation
  - c. 1110-3-294 Interior Design Temperatures
  - d. 1110-3-332 Economic Studies
3. Architectural and Engineering Instructions, Design Criteria dated 13 March 1987
4. Technical Manuals:
  - a. TM 5-785 Engineering Weather Data
  - b. TM 5-800-2 General Criteria Preparation of Cost Estimates
  - c. TM 5-800-3 Project Development Brochure
5. Army Regulations:
  - a. AR 415-15 Military Construction Army (MCA) Program Development
  - b. AR 415-17 Cost Estimating for Military Programming
  - c. AR 415-20 Project Development and Design Approval
  - d. AR 415-28 Department of the Army Facility Classes and Construction Categories
  - e. AR 415-35 Minor Construction, Emergency Construction, and Replacement of Facilities Damaged or Destroyed
  - f. AR 420-10 General Provisions, Organization Function, and Personnel
  - g. AR 5-4 Department of the Army Productivity Improvement Program  
Change 1
6. CEHSC-FU (420.10a), Energy Conservation Investment Program (ECIP) Guidance, dated 25 April 1988.

## LIST OF ABBREVIATIONS

A/C	Air Conditioning
ASHRAE	American Society of Heating Refrigeration and Air Conditioning
CE	Corps of Engineers
DHW	Domestic Hot Water
DOD	Department of Defense
ECIP	Energy Conservation Investment Program
ECO	Energy Conservation Opportunity
EEAP	Energy Engineering Analysis Program
ESOS	Energy Savings Opportunity Survey
EWB	Electric Water Heater
FY	Fiscal Year, October 1 Thru September 30
HVAC	Heating, Ventilating and Air Conditioning
KW	Kilowatt
KWH	Kilowatt-Hour
LCCA	Life Cycle Cost Analysis
MBTU	Million British Thermal Unit
OH&P	Overhead and Profit
POD	Pacific Ocean Division
SIR	Savings to Investment Ratio
SNG	Synthetic Natural Gas
SOW	Scope of Work
SPB	Simple Payback Period
TM	Technical Manual
UPW	Uniform Present Worth
USASCH	U.S. Army Support Command, Hawaii

## EXECUTIVE SUMMARY

### 1. INTRODUCTION

This Energy Savings Opportunity Survey (ESOS) is to identify Energy Conservation Opportunities (ECO's) which are practical and economical for the reduction of energy consumption in accordance with the Army Facilities Energy Plan.

### 2. GENERAL SCOPE OF WORK

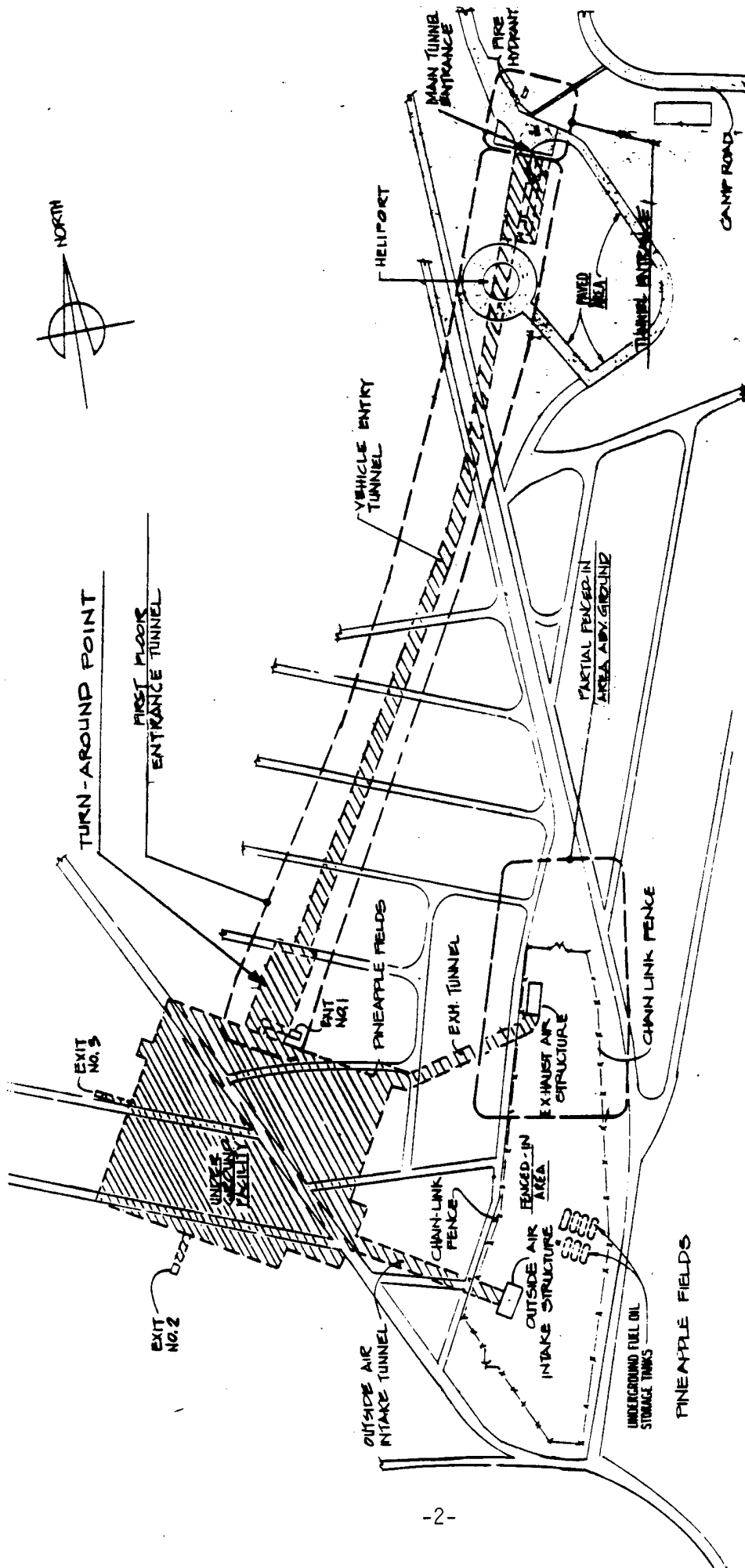
The work to be performed under this project includes the following tasks:

- A. Coordinate with the on-going and proposed related projects.
- B. Conduct a limited site survey required to identify applicable ECO's and obtain necessary data to evaluate the ECO's.
- C. Evaluate applicable ECO's to determine their feasibility in accordance with current criteria.
- D. Prepare programming and implementation documents for the recommended ECO's.
- E. Prepare a comprehensive report to present the work performed including energy analysis, the results and recommendations.

The facility covered under this project is the U.S. Army Field Station Kunia, located at Kunia in Oahu, Hawaii, (See attached Figures 1, 2, 3 and 4).

### 3. SPECIFIC SCOPE OF WORK

The following are the specific items defined in ANNEX B of the project scope of work dated May 26, 1987 and as amended during the preproposal meeting.



SITE PLAN  
1" = 200'

FIGURE 1  
SITE PLAN



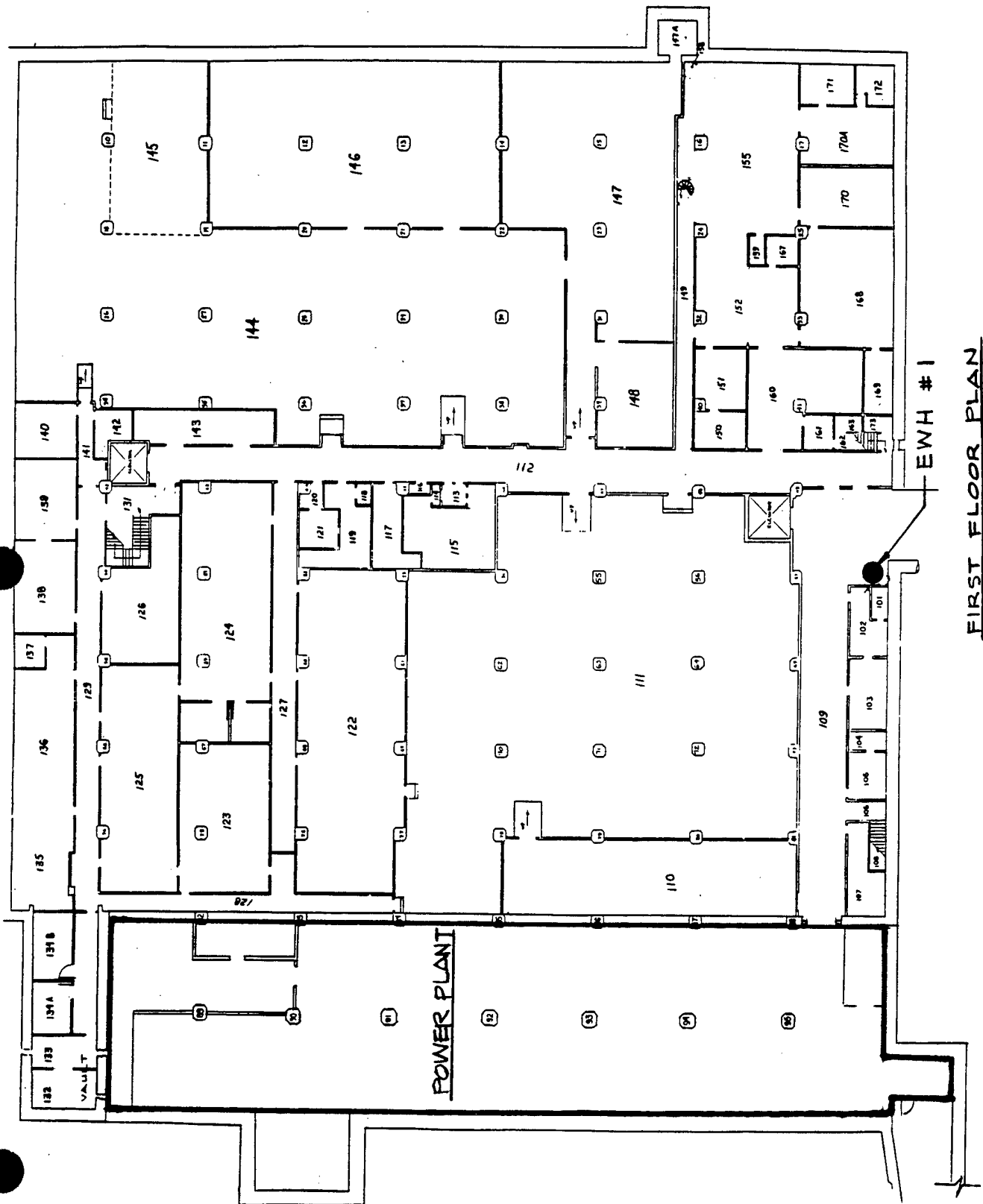


FIGURE 2  
FIRST FLOOR PLAN





- A. Survey of energy savings opportunities in the dining hall and snack bar areas.
- B. Consolidation of the individualized water heaters to the central domestic hot water system.
- C. Analysis of the possibility to use more efficient entrance tunnel exhaust and lighting system.
- D. Evaluation of the possibility to install a dimmer or alternate switching for fluorescent lighting in the computer area (third floor).
- E. Analysis of the possibility to use more efficient lighting for the parking area, upper fenced area and power plant.
- F. Survey of cooling requirements and operations for the microwave facility in the upper exhaust tunnel to tie-in with the central chilled water system.
- G. Evaluation of the underground ventilation system to ensure the most efficient outside air system which would maintain a positive pressure in the entire facility.

Although the original scope of work included a survey of the chilled water system, it was deleted from the scope of this study because of another ongoing project that already encompasses the entire chilled water system. The other projects are under design by other A/E's as described in the next paragraph.

#### 4. RELATED PROJECTS

The Government informed this A/E that the following MCA projects are currently under design and may affect this study:

A. FY86 MCA PN173, A/C Upgrade

A project to upgrade the existing A/C system including the replacement of chilled water lines, air handling units, and improvements to the ventilation system.

B. FY88 MCA PN12, Power Upgrade

A project to convert 2.4 KV electrical system to 4.16 KV system. The work includes replacing transformers, installing bus ducts, and constructing a primary substation.

C. FY88 MCA PN 13, Life/Safety Upgrade

A project to construct additional corridors, stairways, exterior exits, sprinkler system, enclosure of stairways, and upgrading the alarm system.

D. FY88 MCA PN 9215460, Operations General Purpose

A project to renovate the facility by adding raised floors and drop ceilings on the second and third floors, renovating office spaces on the first and second floors, and renovating A/C systems in these impacted areas.

Reviewing the scope of the above projects, it was found that the first project, FY86 MCA PN 173, A/C Upgrade has a potential impact on this project. After the field investigation, a close coordination with Mechanical Engineers of Hawaii Corporation, the firm undertaking the project design, was made in order to incorporate their design approaches in this study.

5. ENERGY CONSERVATION OPPORTUNITIES

5.1 Applicable Energy Conservation Opportunities

During the field investigation, the suggested ECO's as listed in Annex A of the contract scope were carefully evaluated to select potential ECO's under this study. The following are the potential ECO's that were analyzed for their feasibility:

A. Architectural ECO's

Since the facility is an underground structure, no architectural ECO is applicable.

B. Mechanical ECO's

M-1 Timeclock control of A/C system in dining area.

M-2 Convert A/C system to chilled water system for microwave facility.

M-3 Consolidate individual electric water heaters to central system.

M-4 Timeclock control of kitchen exhaust system.

M-5 Improve entrance tunnel ventilation.

C. Electrical ECO's

E-1 Install dimmers for computer area lighting.

E-2 Replace incandescent fixtures with fluorescent in power plant.

E-3 Replace incandescent reflector type fixtures with fluorescent in A/C plant.

E-4 Replace incandescent fixtures with fluorescent for A/C plant's motor control center.

E-5 Replace incandescent fixtures with HPS fixtures along perimeter fence.

5.2 Inapplicable Energy Conservation Opportunities

The other suggested ECO's in Annex A of the contract scope are inapplicable. The following are inapplicable ECO's and the reasons for their deletion:

A. Insulation - Not applicable as the facility is an underground structure.

B. Storm Windows - Not applicable as the facility is an underground structure.

- C. Weatherstripping - Not applicable as the facility is an underground structure.
- D. Insulated Panel - Not applicable as the facility is an underground structure.
- E. Solar Films - Not applicable as the facility is an underground structure.
- F. Vestibules - No vestibules are involved.
- G. Load Dock Seals - No loading docks are involved.
- H. Reduction of Glass Area - Not applicable as the facility is an underground structure.
- I. Replace Kitchen Light Fixture - Existing kitchen fixtures are energy efficient fixtures.
- J. Shutdown Energy to H.W. Heater - The facility is in 24-hour operation.
- K. Improve Power Factor - Not in the scope.
- L. High Efficiency Motor Replacement - All motors will be replaced under Project PN 173, A/C Upgrade.
- M. Night Setback/Setup Thermostats - The facility is in 24-hour operation.
- N. Infrared Heaters - No heating is involved.
- O. Economizer Cycle - Not practical because of warm climate.

- P. Control H.W. Pump - Not practical since 24-hour operation requires continuous circulation of hot water.
- Q. FM Radio Controls - The facility is a single underground facility.
- R. Radiator Controls - No radiators are involved.
- S. Decentralize D.H.W. Heaters - The central heat pump system is more efficient.
- T. Install Shower Flow Restrictors - No showers are involved.
- U. Heat Reclaim from Hot Refrigerant Gas - No refrigeration system is involved.
- V. Prevent Air Stratification - No heating is involved.
- W. Boiler Oxygen Trim Control - No boiler is involved.
- X. Revise Boiler Control - No boiler is involved.
- Y. Chiller Replacement - Not in the scope.
- Z. Replace Absorption Chiller - No absorption chiller is involved.
- AA. Chiller Controls - Not in the scope.
- BB. Insulate Steam and Condensate Lines - No steam and condensate lines are involved.
- CC. Return Condensate - No condensate is involved.
- DD. Heat Reclaim from Family Housing Condenser Units - No family housing is involved.



- EE. Transformer Over-Voltage and Loading - Not in the scope.
- FF. Reduce Air Flow - All A/C systems are constant volume systems.
- GG. Waste Heat Recovery - Insignificant temperature difference.
- HH. Thermal Storage - No discounted power cost.
- II. Steam Trap Inspection - No steam trap is involved.
- JJ. Instantaneous H.W. Heater - Not practical since H.W. must be continually circulated. Conduction and convection savings very minimal.
- KK. Air Curtains - The facility is pressurized.
- LL. Occupancy Sensors to Control HVAC - Not practical due to continuous occupant usage over 24-hour period.
- MM. Occupancy Sensors to Control Lighting - Not practical due to continuous occupant usage over 24-hour period.

### 5.3 Maintenance Items

Some applicable ECO's which are labor intensive and can be implemented by installation maintenance personnel using regular maintenance and repair funds are classified as Maintenance Items. The following are the list of recommended Maintenance Items.

- A. Reset the thermostat to 78°F in the dining area.
- B. Replace all burnt out fluorescent lamps and ballasts with energy saving type (applicable to all areas not marginally illuminated). Clean diffusers prior to relamping.
- C. Reset the thermostat to 78°F in the snack bar.

- D. Reset electric water heaters to 120°F.
- E. Replace damaged diffusers for snack bar light fixtures.
- F. Disconnect ballasts for light fixtures with two of four lamps removed in the computer area, 3rd floor.
- G. Block-off forty (40) exhaust outlets in the entrance tunnel.

#### 6. ENERGY AND LIFE CYCLE ANALYSIS

All applicable ECO's were analyzed and evaluated for their economic feasibility of implementation in accordance with the latest criteria. The evaluation process includes energy and other savings analysis, project cost estimate, and life cycle cost (LCC) analysis to determine the cost effectiveness. Cost effective projects are defined as those for which the Savings to Investment Ratio (SIR) is 1.0 or greater.

The evaluated ECO's are listed on Table 1 by their SIR rank. Table 1 also shows the estimated construction cost, annual energy savings in MBTU and dollars, SIR and Simple Payback Period (SPB) for individual projects.

#### 7. PROJECT SUMMARY AND RECOMMENDATIONS

As shown on Table 1, the eight (8) projects recommended for funding represent a total construction cost of \$89,782, annual energy savings of 845.15 MBTU, and a total annual savings of \$15,604. Their average SIR is 3.54 and SPB is 4.6 years. For these projects, the implementation documents are prepared and included in the main report.

Two (2) ECO's are not recommended. ECO E-1 (Install Dimmers for Computer Area Lighting) failed to qualify due to its SIR being lower than 1.0. Although the SIR of ECO M-1 (Timeclock Control of A/C System in Dining Area) is 7.94, much higher than 1.0, it is not recommended because of that the timeclock control of the air handling unit serving the Dining Area would jeopardize the operation of adjacent areas which are served by the same air handling unit.

TABLE 1

## LIST OF ECO'S RANKED BY SIR

ECO No.	DESCRIPTION	INVESTMENT COST (\$)	ENERGY SAVINGS		SIR	SPB
			MBTU/YR	\$/YR		
RECOMMENDED PROJECTS						
E-2	REPL. INCAN TO FLOUR.	\$7,046	88.70	\$3,971	6.28	1.8
E-3	REPL. INCAN TO FLOUR.	\$3,031	52.32	\$1,661	5.99	1.8
E-4	REPL. INCAN TO FLOUR.	\$972	8.20	\$468	5.42	2.1
M-4	TIMECLOCK, KITCHEN EXH.	\$17,360	240.27	\$4,435	2.05	3.9
E-5	REPL. INCAN TO HPS	\$25,450	32.05	\$3,669	1.65	6.9
M-5	IMPR. TUNNEL VENTILATION	\$22,050	164.44	\$3,036	1.11	7.3
M-3	CONSOLIDATE DHW	\$15,847	82.67	\$1,526	1.00	10.4
TOTALS		\$91,756	668.65	\$18,766	3.36	4.9
NOT RECOMMENDED PROJECTS						
M-1 *	TIMECLOCK, A/C	\$1,922	90.82	\$1,677	7.00	1.1
M-2	CONVERT A/C TO CH WATER	\$8,666	52.56	\$970	0.90	8.9
E-1	INSTALL DIMMERS	\$84,809	147.15	\$2,716	0.33	31.2
TOTALS		\$93,475	199.71	\$3,686	0.62	20.1

\* ALTHOUGH SIR OF ECO M-1 IS GREATER THAN 1.0, IT IS NOT RECOMMENDED BECAUSE THE AIR HANDLING UNIT FOR THE DINING AREA SERVES OTHER AREAS TOO.

As illustrated by the results of this survey, most of the energy savings are attributed to improvements on the air conditioning and ventilation systems and secondly, to the replacement of lighting fixtures with more efficient fixtures.

This survey also identified numerous Maintenance Items. One item of note is to block-off forty (40) exhaust outlets in the entrance tunnel into the facility. This item is not related to energy conservation but is recommended as a Maintenance Item to improve the ventilation at the turnaround point of the tunnel.

#### 8. BUILDING ENERGY END-USE

The building energy end-use analysis was prepared in order to estimate the existing building energy consumption as a baseline for the assessment of energy savings resulted from the recommended ECO's. For the analysis, the building energy is divided into four (4) categories; air conditioning, lighting, domestic hot water and other equipment.

The results of building energy end-use analysis and the assessment of recommended ECO's energy savings are shown on Table 2 and Figures 5 through 11.

TABLE 2  
-----  
BUILDING ENERGY END-USE ANALYSIS  
-----

CATEGORY	KWH/YR	MBTU/YR	\$/YR	%	MBTU/SF	REDUCTION
PRESENT ENERGY CONSUMPTION OF ENTIRE FACILITY						
A/C	4,162,891	14,207.95	\$262,279	36.5	0.061	
LIGHTING	5,110,197	17,441.10	\$321,962	44.7	0.075	
D.H.W.	74,237	253.37	\$4,677	0.7	0.001	
OTHERS	2,072,616	7,073.84	\$130,583	18.1	0.030	
	-----	-----	-----	-----	-----	
TOTAL	11,419,941	38,976.26	\$719,501	100.0	0.167	
PRESENT ENERGY CONSUMPTION OF SYSTEMS INVOLVED IN ECO'S						
A/C	477,388	1,629.33	\$30,077	60.7		
LIGHTING	269,440	919.60	\$16,976	34.2		
D.H.W.	40,088	136.82	\$2,526	5.1		
OTHERS	0	0.00	0	0		
	-----	-----	-----	-----		
TOTAL	786,916	2,685.74	\$49,579	100.0		
ENERGY SAVINGS OF RECOMMENDED ECO'S						
A/C	160,586	548.08	\$10,118	58.9		
LIGHTING	96,227	328.42	\$6,063	35.3		
D.H.W.	15,867	54.15	\$1,000	5.8		
OTHERS	0	0.00	\$0	0.0		
	-----	-----	-----	-----		
TOTAL	272,680	930.66	\$17,180	100.0		
PROJECTED ENERGY CONSUMPTION OF SYSTEMS INVOLVED IN ECO'S						
A/C	316,802	1,081.25	\$19,960	61.6		33.6%
LIGHTING	173,213	591.18	\$10,913	33.7		35.7%
D.H.W.	24,221	82.67	\$1,526	4.7		39.6%
OTHERS	0	0.00	\$0	0.0		0.0%
	-----	-----	-----	-----		-----
TOTAL	514,236	1,755.09	\$32,399	100.0		34.7%
PROJECTED ENERGY CONSUMPTION OF ENTIRE FACILITY						
A/C	4,002,305	13,659.87	\$252,161	35.9	0.059	3.9%
LIGHTING	5,013,970	17,112.68	\$315,900	45.0	0.074	1.9%
D.H.W.	58,370	199.22	\$3,678	0.5	0.001	21.4%
OTHERS	2,072,616	7,073.84	\$130,583	18.6	0.030	0.0%
	-----	-----	-----	-----	-----	-----
TOTAL	11,147,261	38,045.60	\$702,322	100.0	0.164	2.4%

# BUILDING ENERGY END-USE ENTIRE FACILITY

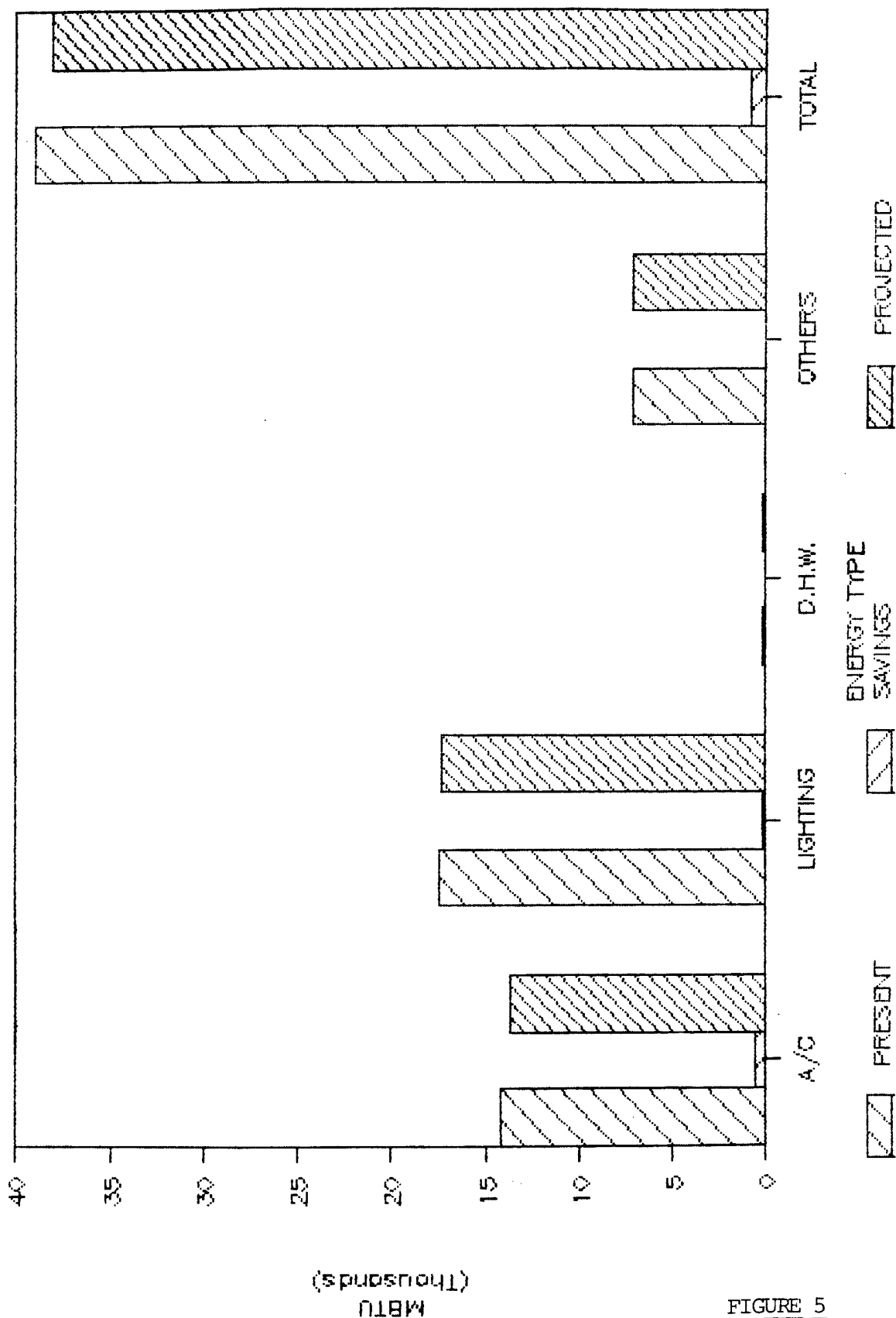


FIGURE 5  
BUILDING ENERGY END USE

# BUILDING ENERGY END-USE

RECOMMENDED EEO'S ONLY

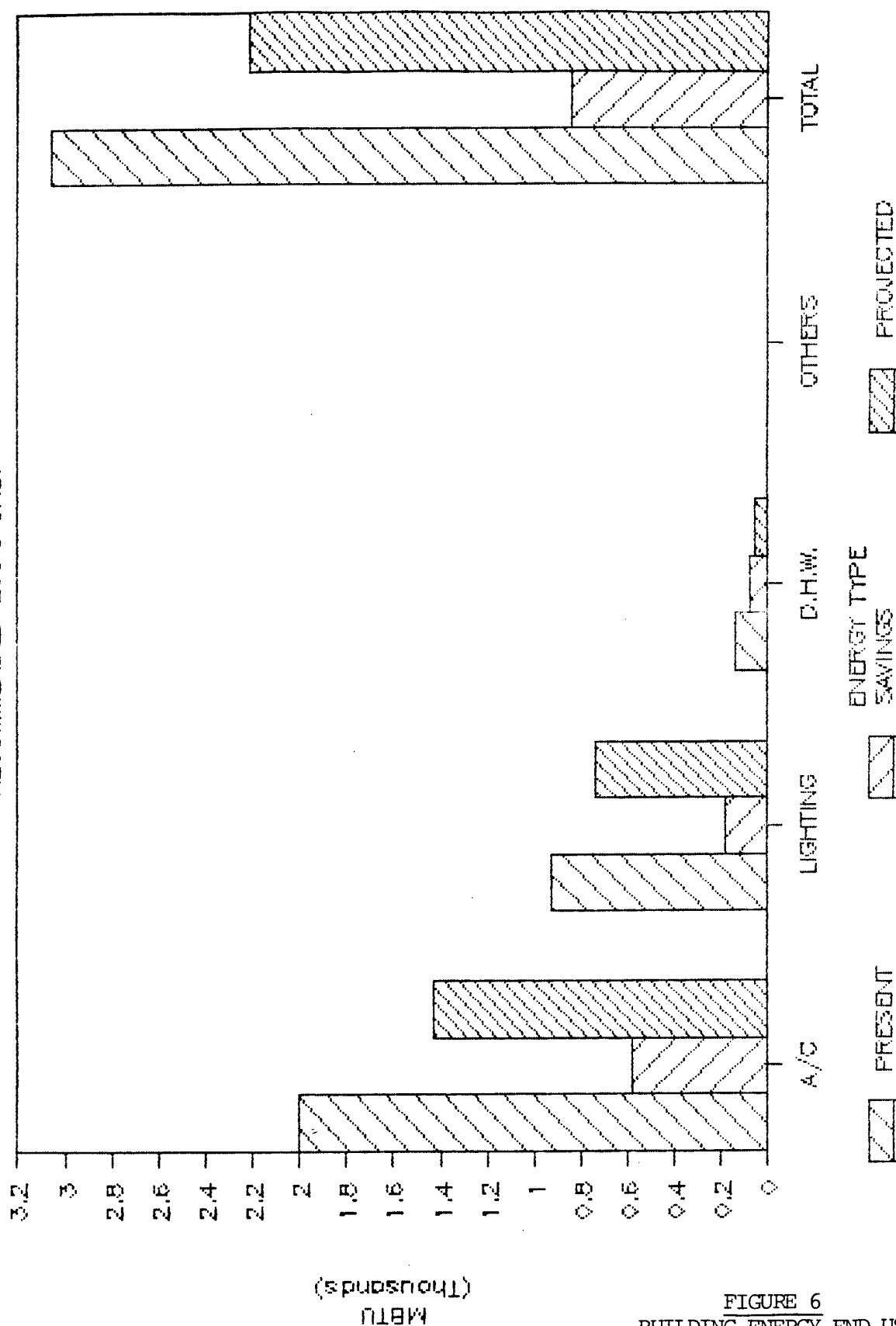


FIGURE 6  
BUILDING ENERGY END USE

# PRESENT ENERGY CONSUMPTION ENTIRE FACILITY

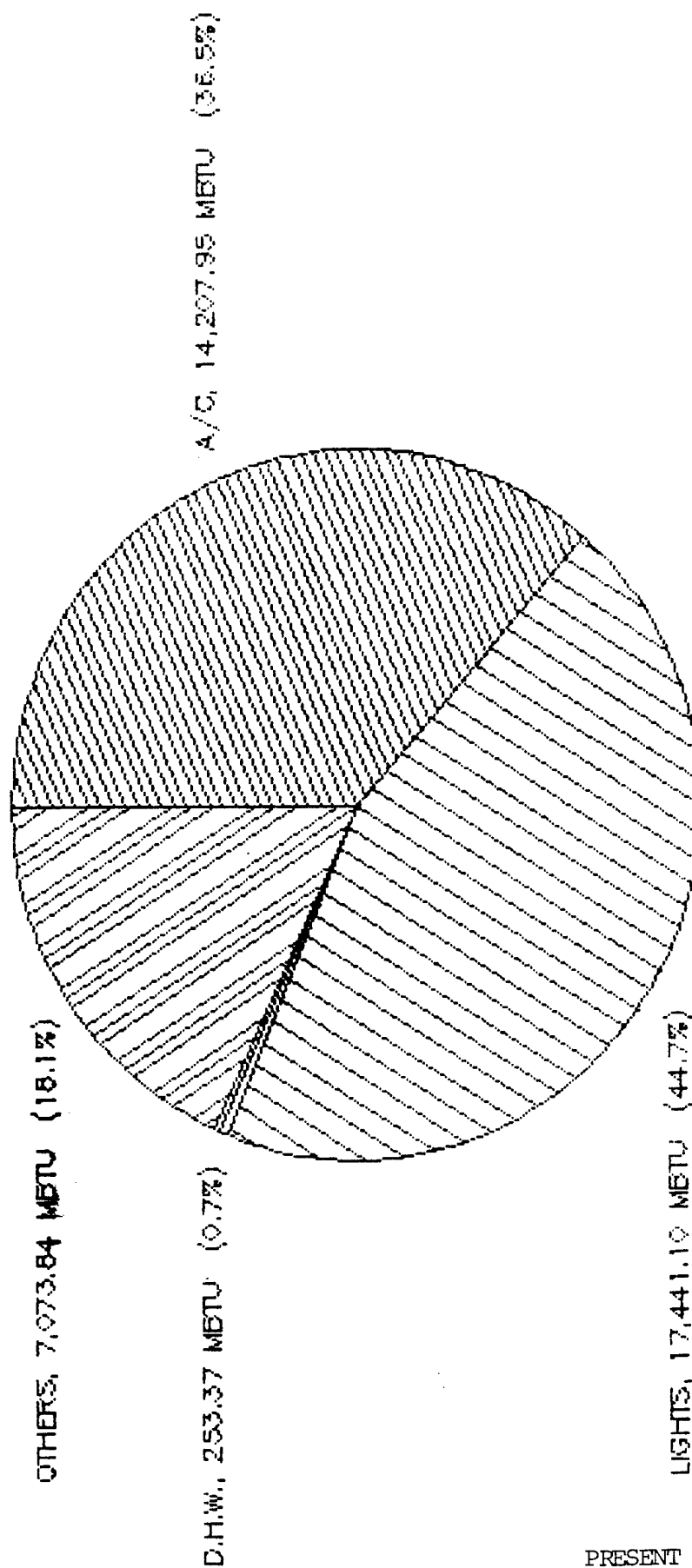


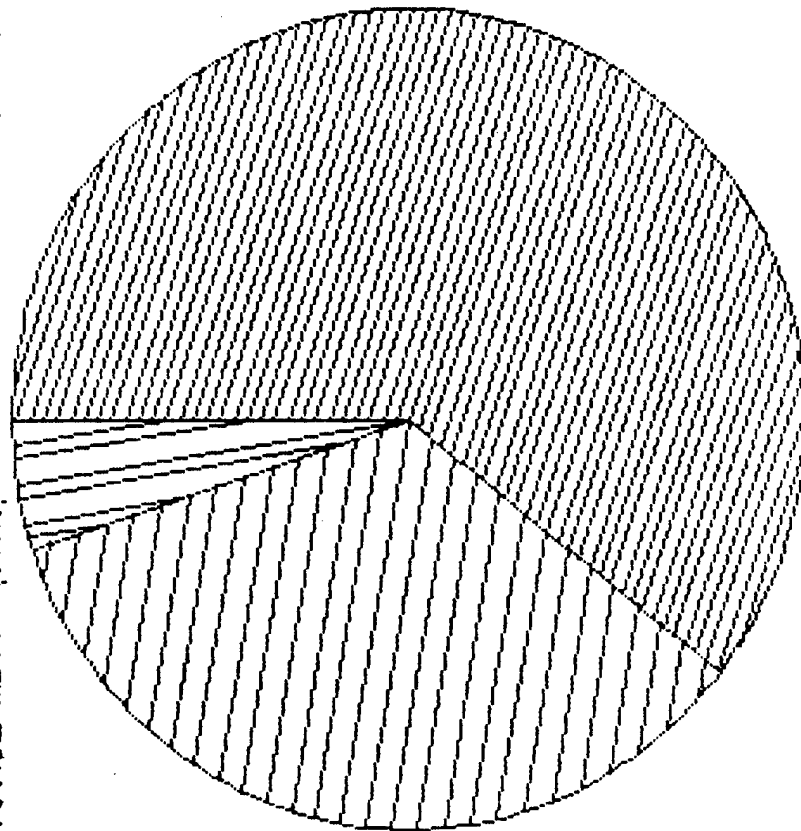
FIGURE 7  
PRESENT ENERGY CONSUMPTION



# PRESENT ENERGY CONSUMPTION

RECOMMENDED ECO'S ONLY

D.H.W., 136.82 MBTU (5.1%) OTHERS, 9 MBTU (0.0%)



A/C, 1,629.33 MBTU (60.7%)

LIGHTS, 919.60 MBTU (34.2%)

FIGURE 8  
PRESENT ENERGY CONSUMPTION

# ENERGY SAVINGS OF ECO'S RECOMMENDED ECO'S ONLY

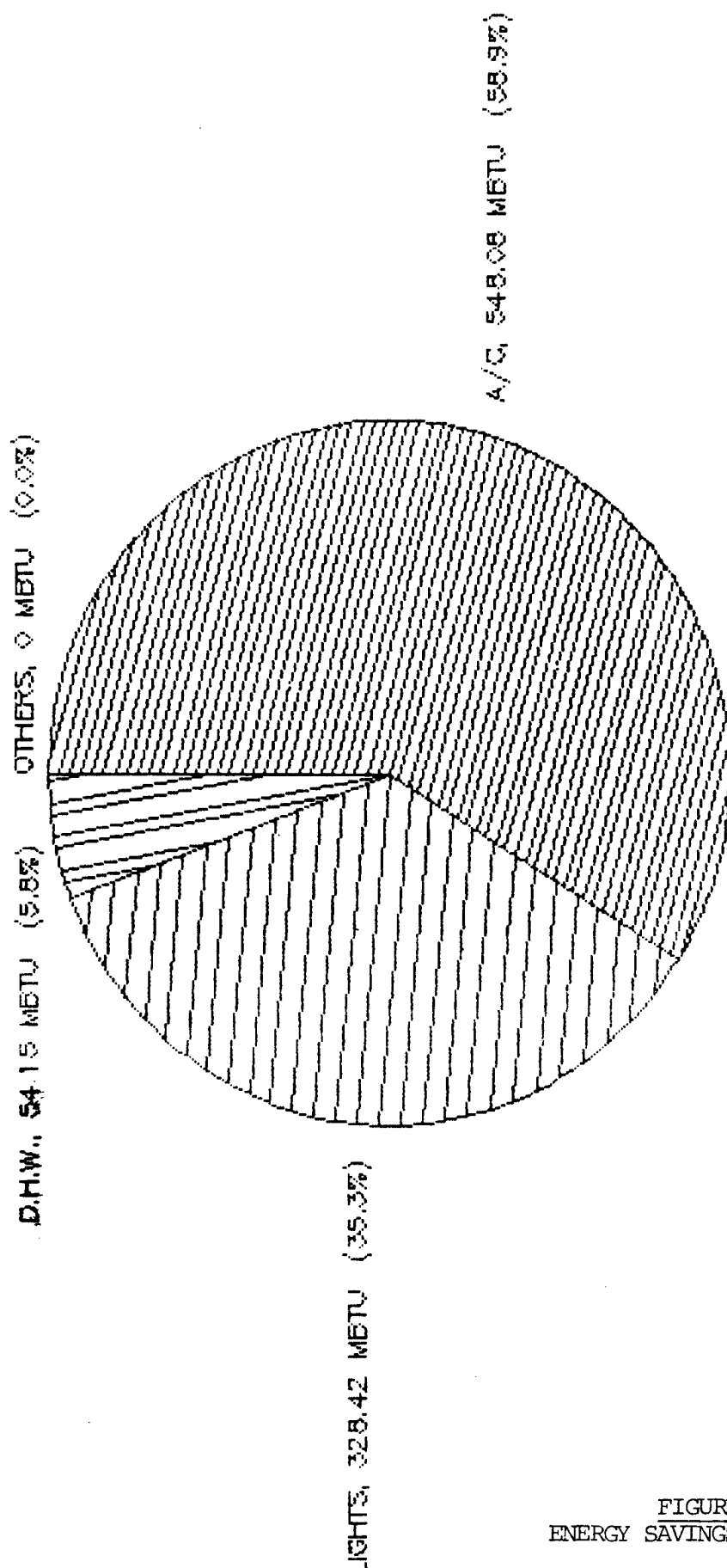


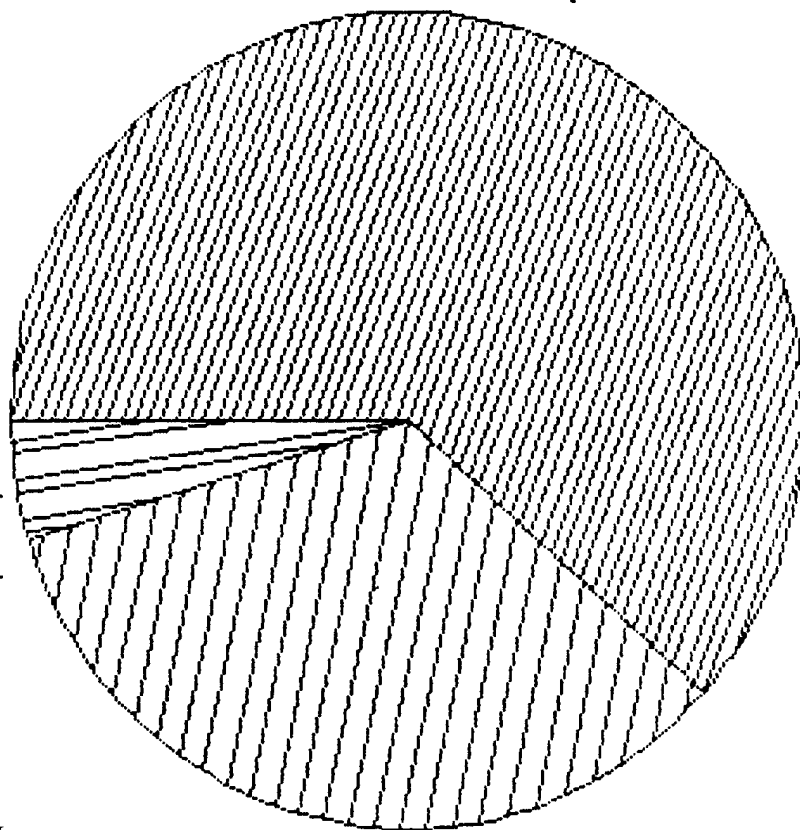
FIGURE 9  
ENERGY SAVINGS BY ECO's

# PROJECTED ENERGY SAVINGS

RECOMMENDED ECO'S ONLY

D.H.W., 82.67 MBTU (4.7%) OTHERS, 0 MBTU (0.0%)

LIGHTS, 591.18 MBTU (33.7%)



A/C, 1,424.22 MBTU (61.6%)

# PROJECTED ENERGY SAVINGS

ENTIRE FACILITY

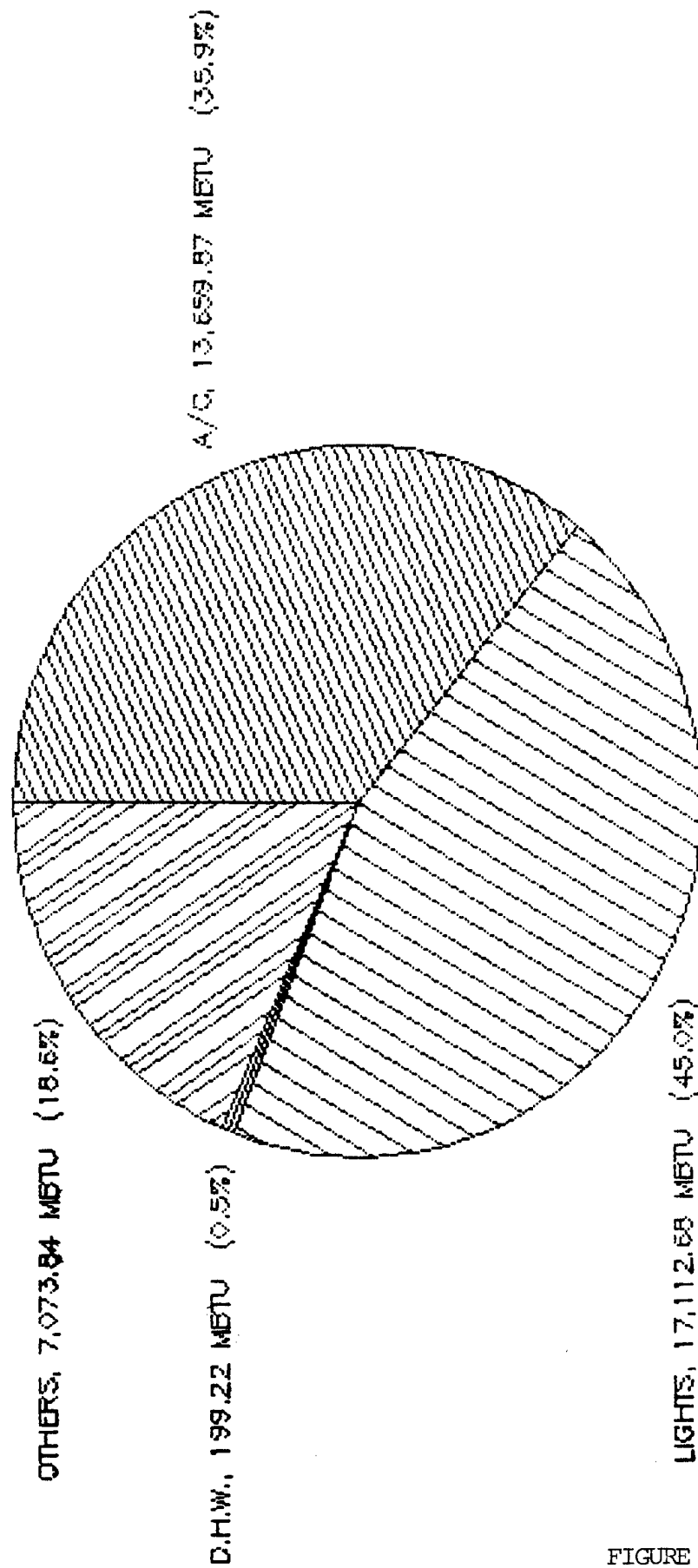


FIGURE 11  
PROJECTED ENERGY CONSUMPTION